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# The independent relationship between systemic inflammation and fragmented QRS complexes in patients with stable angina pectoris

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## Abstract

**Background:** QRS complex fragmentations can frequently be seen on routine ECG with narrow or wide QRS complex. Fragmented QRS complexes (fQRS) are defined as various RSR' patterns ( $\geq 1$  R' or notching of S wave or R wave) in two contiguous leads corresponding to a major coronary artery territory. In previous studies, fQRS has been associated with increased morbidity and mortality, sudden cardiac death and recurrent cardiovascular events. The causative relationship between fQRS and cardiac fibrosis has been shown, but it has not been extensively studied whether there are different mechanisms for the development of fQRS.

**Aim:** To interrogate the relationship between systemic inflammation and the presence of fQRS in patients with stable angina pectoris.

**Methods:** A total of 353 eligible patients who underwent coronary angiography with a suspicion of coronary artery disease (CAD) at our institution between April 2010 and December 2010 were enrolled consecutively. All patients had angina pectoris or angina equivalent symptoms with either a positive treadmill test or myocardial perfusion study. Patients with recent acute coronary syndrome either with or without ST-segment elevation, significant organic valve disease, and patients having any QRS morphology with QRS duration  $\geq 120$  ms, as well as patients with permanent pacemakers, were excluded from the study.

**Results:** Patients with fQRS had older age ( $p = 0.01$ ), higher C-reactive protein (CRP) ( $p < 0.001$ ), longer QRS time ( $p < 0.001$ ) and more severe CAD ( $p < 0.001$ ) compared to patients with non-fragmented QRS. When we performed multiple logistic regression analysis, we found that the fragmentations in QRS complexes were positively related with increased CRP (OR: 3.8, 95% CI 1.573–9.278,  $p = 0.003$ ), and QRS duration (OR: 1.1, 95% CI 1.008–1.101,  $p = 0.019$ ) and negatively related with left ventricular ejection fraction [%] (OR: 1.0, 95% CI 0.914–0.992,  $p = 0.020$ ).

**Conclusions:** In our study, we found that fQRS was independently related with increased CRP and QRS duration as well as left ventricular systolic dysfunction. Fragmented QRS, which may come about as an end effect of inflammation at cellular level, can represent increased cardiac risk by different causative mechanisms in patients with stable CAD. In addition, fragmentations on ECG may be useful for identifying patients who should be investigated and treated for their increased inflammatory status and possible chronic infections.

**Key words:** fragmented QRS, fQRS, coronary artery disease, cardiovascular risk, inflammation, left ventricular dysfunction, coronary atherosclerotic burden

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## INTRODUCTION

QRS complex fragmentations are frequently seen on routine surface electrocardiograms (ECG) with narrow or wide QRS complex which include paced rhythm, bundle branch block or ventricular premature beats [1]. These fragmentations on surface ECG have been found to be associated with increased adverse cardiac events in previous studies [2–5].

Fragmented QRS complexes (fQRS) on a 12-lead resting ECG are defined as various RSR' patterns with or without Q waves without a typical bundle-branch block in two contiguous leads corresponding to a major coronary artery territory [6]. Based on their duration, they are sub-classified into two subgroups as fQRS complexes with QRS duration < 120 ms or  $\geq$  120 ms (fragmented wide-QRS complex) and they can be found on ECG with different QRS morphologies. Sometimes, fQRS might be the only ECG marker of myocardial damage in patients with non-Q myocardial infarction and in patients with resolved Q wave [6].

The association between fQRS and increased morbidity and mortality, sudden cardiac death and recurrent cardiac events has been previously studied [4, 5, 7–10]. In these studies, cardiac fibrosis has been shown to be the main causative mechanism [11, 12]. Additionally, fQRS may represent altered ventricular depolarisation which may result due to different mechanisms, not only fibrosis. Therefore, in patients with stable coronary artery disease (CAD) or normal coronary arteries, there may be a possible causative association of fQRS with some factors including systemic inflammation.

In this study, we aimed to interrogate the relationship between fQRS and systemic inflammation in patients with a suspicion of CAD.

## METHODS

### *Patient population and study protocol*

The current study had a cross-sectional observational design. The study was conducted in the cardiology clinic at the Rize Education and Research Hospital in Rize, Turkey; 353 eligible patients who underwent coronary angiography with a suspicion of CAD at our outpatient clinic between April 2010 and December 2010 were enrolled consecutively. All patients had stable angina pectoris or angina equivalent symptoms with either a positive treadmill test or myocardial perfusion study.

Patients with recent acute coronary syndrome either with or without ST-segment elevation (within one month prior to enrollment), significant organic valvular heart disease, patients with any QRS morphology with QRS duration  $\geq$  120 ms (bundle-branch block patterns; left, incomplete or complete right bundle-branch block, and intra-ventricular conduction delay), as well as patients with permanent pacemakers, were excluded from the study.

The patients were firstly divided into two groups according to the presence or absence of fQRS. Afterwards, additional categories determined by number of fQRS were used for the presentation of data. Finally, logistic regression analysis was used to determine independent predictors of fQRS.

### *Routine measurements*

Blood samples were drawn by venipuncture to perform routine blood chemistry after fasting for at least 8 h before coronary angiography. Fasting blood glucose, serum creatinine, total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, and triglyceride levels were recorded. Glucose, creatinine, and lipid profiles were determined by standard methods. White blood cell (WBC, leukocyte) counts were obtained from an automated cell counter (Coulter Gen-S, COULTER Corp, Miami, FL, USA). Serum C-reactive protein (CRP) levels were determined by the nephelometric method.

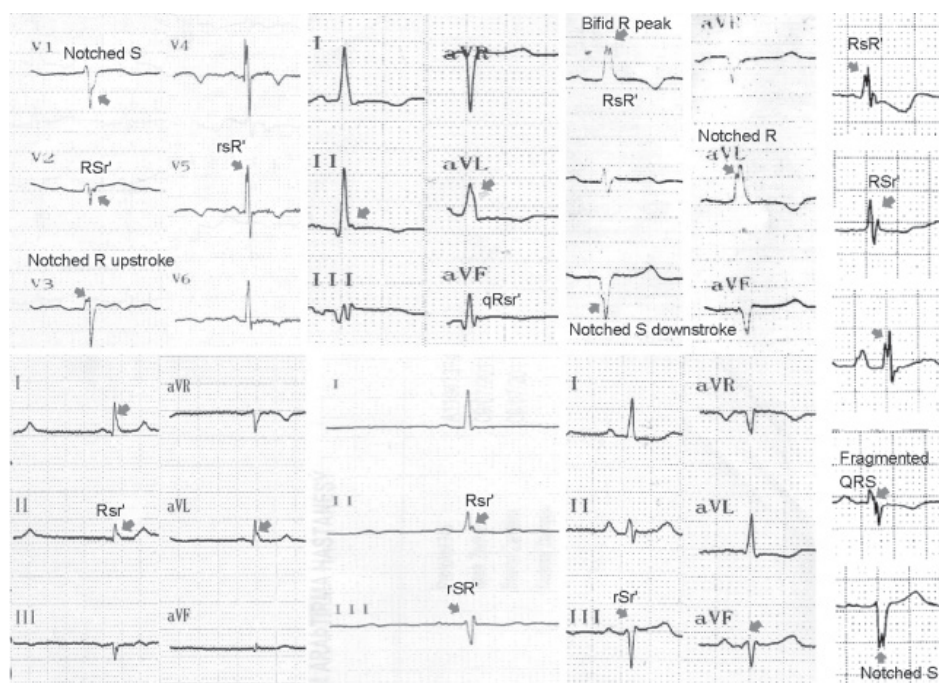
### *ECG*

A 12-derivation surface ECG was obtained from all patients. The resting 12-lead ECG (Nihon Kohden — cardiofax S ECG-1250K, filter range 0.5 Hz to 150 Hz, AC filter 60 Hz, 25 mm/s, 10 mm/mV) was analysed by two independent clinicians who were blinded to echocardiographic data. The fQRS was defined by the presence of various RSR' patterns (QRS duration < 120 ms) with or without Q wave, which include an additional R wave (R' prime) or notching of the R wave or S wave, or the presence of more than one R prime (fragmentation) without typical bundle branch block in two contiguous leads corresponding to a major lead set for major coronary artery territory (Fig. 1). A notch on an R or S wave was defined as a definite but transient reversal of direction of the main deflection. The presence of fQRS was detected by inspection of tracings with the naked eye. Analysis of the standard 12-lead ECG was performed without using any magnification. The inter-observer concordance rate with regard to detecting the presence of fQRS was 97.8% between the two readers. In case of disagreement, the final diagnosis was achieved by mutual agreement. The intra-observer concordance rate was 98%. Fragmentations were considered to be present if a visually identifiable signal was demonstrated in all complexes of a particular lead. In this way, for statistical analysis, fQRS was defined to be present if found in  $\geq$  2 contiguous leads in anterior, lateral or inferior derivations. We also used the concept of 'number of fQRS' which represents the number of fQRS  $\geq$  2 because 'one fQRS complex' was on its own not accepted for the presence of fQRS.

The QRS time was measured by manual and digitalised methods and no significant difference was found between the methods. It was determined by the longest QRS in any lead.

### *Echocardiography*

Standard transthoracic and Doppler echocardiographic examinations were performed by a 3.25-MHz transthoracic transducer connected to a Vivid 5 System (GE Vingmed Ultrasound AS, Horten, Norway). Two echocardiographers who were unaware of the study performed the examinations. Left ventricular (LV) end-systolic dimension, end-diastolic dimension, wall thickness, and left atrial volume were measured according to the guidelines of the American Society of Echocardi-



**Figure 1.** The various types of notched and fragmented QRS complexes (fQRS) used to select patients for our study. Different fQRS patterns are shown by arrows including rSr', rSR', RSr', notched R up-stroke, notched S down-stroke, bifid R peak, and bifid R nadir

graphy [13]. LV end-systolic and end-diastolic volumes and ejection fraction (EF) were measured from the apical four-chamber view and two-chamber views using the modified Simpson's method [14]. Systolic pulmonary artery pressure was estimated from the systolic trans-tricuspid pressure gradient (in mm Hg) using the simplified Bernoulli equation.

#### **Evaluation of the extent and severity of the coronary lesions at angiography**

Standard selective coronary angiography with at least four views of the left coronary system and two views of the right coronary artery was performed to all patients using the Judkins technique. Coronary angiograms were recorded on compact discs in DICOM format. Atherosclerotic coronary involvement was assessed by the number of vessels involved (vessel score) and by a severity score. Significant stenosis was determined visually and defined as  $\geq 50\%$  reduction in lumen diameter in any view compared to the nearest normal segment. Vessel score ranged from 0 to 4, depending on the vessels involved (0: normal, 1:  $< 50\%$  luminal narrowing, 2, 3 and 4:  $\geq 50\%$  luminal narrowing for one, two and three vessels). Coronary atherosclerotic burden was assessed using the Gensini score.

Gensini score which considers both the extent and the severity of the lesions at coronary angiography was calculated for each patient [15]. This scoring system grades the stenosis in the epicardial coronary arteries (1 for 1–25% stenosis, 2 for 26–50% stenosis, 4 for 51–75% stenosis, 8 for 76–90% stenosis, 16 for 91–99% stenosis, and 32 for

total occlusion) and multiplies this number by a constant number determined according to the anatomical position of the lesion.

#### **Statistical analysis**

Continuous variables were given as mean  $\pm$  standard deviation; categorical variables were defined as percentages. Continuous variables were compared by Student t test and the  $\chi^2$  test was used for the categorical variables between two groups. Mean values were compared by ANOVA among different groups. Logistic regression analysis with Backward LR method was used for multivariate analysis of independent variables including age, uric acid, creatinine, CRP and the presence of CAD, which were significantly different in univariate analysis between two groups. After exclusion of irrelevant variables from model, logistic regression analysis with enter method was performed with the remaining significant variables and then the obtained results were presented. All tests of significance were two-tailed. Statistical significance was defined as  $p < 0.05$ . SPSS statistical software (SPSS 15.0 for Windows, Inc., Chicago, IL, USA) was used for all statistical calculations.

## **RESULTS**

Baseline clinical characteristics are shown in Table 1. Patients with fQRS had older age ( $p = 0.01$ ), higher CRP ( $p < 0.001$ ), longer QRS time ( $p < 0.001$ ) and more severe CAD ( $p < 0.001$ ) compared to patients with non-fragmented QRS. In Table 2, the presence and number of fQRS are presented in

**Table 1.** Baseline characteristics of the study population

Parameters (n = 353)	Non-fragmented QRS (n = 237)	Fragmented QRS (n = 116)	P
Age [years]	58 ± 11	61 ± 10	0.011
Body mass index [kg/m <sup>2</sup> ]	30 ± 5	30 ± 5	NS
Gender (male)	61%	70%	NS
Hypertension	59%	64%	NS
Diabetes mellitus	30%	33%	NS
Smoking	26%	26%	NS
Hyperlipidaemia	70%	77%	NS
Family history of CAD	37%	32%	NS
Systolic blood pressure [mm Hg]	132 ± 16	136 ± 19	NS
Diastolic blood pressure [mm Hg]	82 ± 10	81 ± 11	NS
Fasting plasma glucose [mg/dL]	116 ± 47	121 ± 42	NS
Blood urea nitrogen [mg/dL]	37 ± 13	40 ± 18	NS
Creatinine [mg/dL]	0.9 ± 0.2	1.0 ± 0.8	0.047
Uric acid [mg/dL]	5.1 ± 1.5	5.6 ± 1.7	0.009
Total cholesterol [mg/dL]	196 ± 42	203 ± 46	NS
LDL [mg/dL]	124 ± 34	132 ± 40	NS
HDL [mg/dL]	43 ± 10	42 ± 12	NS
Triglyceride [mg/dL]	146 ± 79	148 ± 95	NS
Leukocytes [10 <sup>3</sup> /mm <sup>3</sup> ]	7,163 ± 2,012	7,346 ± 2,150	NS
Platelets [10 <sup>3</sup> /mm <sup>3</sup> ]	279 ± 69	275 ± 72	NS
C-reactive protein [mg/L]	0.45 ± 0.43	0.86 ± 0.78	< 0.001
Gensini score	12 ± 19	32 ± 38	< 0.001
QRS duration [ms]	88 ± 11	96 ± 11	< 0.001
Echocardiography:			
LVEF [%]	61 ± 10	51 ± 13	< 0.001
LVEDD [cm]	4.7 ± 0.5	5.1 ± 0.7	< 0.001
LVESD [cm]	3.1 ± 0.6	3.6 ± 0.9	< 0.001
LVEDV [cm <sup>3</sup> ]	100 ± 27	130 ± 45	< 0.001
LVESV [cm <sup>3</sup> ]	41 ± 18	69 ± 39	< 0.001
Left atrium [cm]	3.8 ± 0.6	4.1 ± 0.5	0.002
sPAP [mm Hg]	23 ± 7	28 ± 7	< 0.001
Medications:			
ASA	41%	46%	NS
Clopidogrel	3%	6%	NS
ACE-I	25%	30%	NS
ARB	25%	25%	NS
Statin	28%	29%	NS
Beta-blockers	36%	43%	NS
Calcium channel blocker	13%	16%	NS
Nitrate	12%	18%	NS
OAD/insulin	12%	13%	NS

ACE-I — angiotensin converting enzyme inhibitor; ARB — angiotensin II receptor blocker; ASA — acetylsalicylic acid; CAD — coronary artery disease; HDL — high-density lipoprotein; LDL — low-density lipoprotein; OAD — oral anti-diabetic drugs; LVEF — left ventricular ejection fraction; LVEDD — left ventricular end-diastolic diameter; LVESD — left ventricular end-systolic diameter; LVEDV — left ventricular end-diastolic volume; LVESV — left ventricular end-systolic volume; sPAP — systolic pulmonary artery pressure

the groups determined according to the extent and severity of CAD. The presence and number of fQRS and LVEF were significantly different in these groups ( $p < 0.001$ ,  $p < 0.001$

and  $p = 0.049$ , respectively). The fQRS complexes were seen in more than one coronary territory in some patients. Therefore, the study parameters are presented in the groups accor-

**Table 2.** Distribution of the fQRS in subgroups determined for the extent and severity of coronary artery disease (CAD)

Parameters	Normal coronary arteries	CAD			P	
		< 50%	≥ 50% vessels			
			1	2		3
N	89	113	64	48	39	
Gensini score	0 ± 0	4 ± 3	20 ± 16	50 ± 28	69 ± 28	< 0.001
Number of fQRS	0.8 ± 1.3	0.7 ± 1.3	0.9 ± 2.0	2.1 ± 2.1	2.0 ± 2.2	< 0.001
Presence of fQRS	28%	24%	24%	60%	53%	< 0.001

**Table 3.** Distribution of study parameters in subgroups determined according to the fQRS

Parameters	Number of fQRS			P
	0–1	2–3	> 3	
N (353)	237	85	31	
Age [years]	58 ± 11	60 ± 10	63 ± 10	0.021
Weight [kg]	83 ± 15	87 ± 13	84 ± 15	NS
Body mass index [kg/m <sup>2</sup> ]	30 ± 5	31 ± 5	29 ± 4	NS
Creatinine [mg/dL]	0.9 ± 0.2	1.0 ± 0.5	1.1 ± 1.2	0.012
Uric acid [mg/dL]	5.1 ± 1.5	5.5 ± 1.7	5.6 ± 1.5	0.032
C-reactive protein [mg/dL]	0.45 ± 0.43	0.76 ± 0.58	1.13 ± 1.10	< 0.001
Gensini score	12 ± 19	22 ± 30	61 ± 43	< 0.001
Number of obstructed vessels ≥ 50%	1.3 ± 1.2	1.6 ± 1.4	2.8 ± 1.2	< 0.001
QRS duration [ms]	88 ± 11	94 ± 10	101 ± 11	< 0.001
Left ventricular ejection fraction [%]	61 ± 10	54 ± 11	44 ± 14	< 0.001

ding to the number of fQRS (0–1, 2–3 and > 3) in Table 3. Age ( $p = 0.021$ ), creatinine ( $p = 0.012$ ), uric acid ( $p = 0.032$ ), CRP ( $p < 0.001$ ), Gensini score ( $p < 0.001$ ), number of obstructed vessels  $\geq 50\%$  ( $p < 0.001$ ) and QRS duration ( $p < 0.001$ ) were found to significantly correlate with increased numbers of fQRS.

When we performed multiple logistic regression analysis, we found that the fragmentations in QRS complexes were positively related to increased CRP (OR: 3.8, 95% CI 1.573–9.278,  $p = 0.003$ ), QRS duration (OR: 1.1, 95% CI 1.008–1.101,  $p = 0.019$ ) and negatively related to LVEF [%] (OR: 1.0, 95% CI 0.914–0.992,  $p = 0.020$ ; Table 4).

In additional analysis, we searched the possible related factors with fQRS in a specific subgroup consisting of patients with normal coronary arteries. We found that prolonged QRS time significantly ( $87 \pm 10$  vs.  $92 \pm 9$  ms,  $p = 0.046$ ), and CRP with a tendency ( $0.43 \pm 0.38$  vs.  $0.63 \pm 0.59$  mg/dL,  $p = 0.057$ ), were related to fQRS in this subpopulation.

## DISCUSSION

In this study, we aimed to interrogate the possible independent relation between systemic inflammation and the presence of fQRS in patients with stable angina pectoris. Our findings suggested that higher levels of CRP are related to the presence and number of fQRS. Additionally, prolonged QRS time (even

at narrow QRS < 120 ms) and LV systolic dysfunction were independent predictors of QRS complex fragmentations on ECG. To the best of our knowledge, this is the first report demonstrating a potential role of systemic inflammation in the development of fQRS in patients with stable CAD.

Although fQRS is defined by unexpected deviations in the QRS morphology, the specific cause of fractionation on surface ECG is not yet fully understood. fQRS has been shown to predict cardiac events in several populations. Pathophysiologically, fQRS is generally accepted to derive from regional myocardial fibrosis/scar and ischaemia which cause non-homogeneous myocardial electrical activation [16–20]. In patients with ischaemic or non-ischaemic LV dysfunction, fQRS has been shown to be related to myocardial fibrosis [21]. In previous studies in which gadolinium delayed enhancement on cardiac magnetic resonance imaging used to determine myocardial structure, fQRS has been found to be related with extensive myocardial scar [11, 12]. fQRS complexes was also found to be a marker of a prior myocardial infarction, demonstrated by regional perfusion abnormalities with scintigraphic evaluation, which has a substantially higher sensitivity and negative predictive value compared to the Q wave [6, 22]. Regional fQRS patterns denote the presence of a greater corresponding focal regional myocardial scar on stress myocardial perfusion imaging [23]. Our study findings also

**Table 4.** Multivariate analysis using the logistic regression method for the presence of fQRS

Independent variables	Logistic regression				
	$\beta$	SE	Wald	OR (95%CI)	P*
<b>Overall</b>					
CRP [mg/dL]	1.3	0.5	8.8	3.820 (1.573–9.278)	0.003
QRS duration [ms]	0.05	0.02	5.5	1.054 (1.008–1.101)	0.019
LVEF [%]	–0.1	0.02	5.4	0.953 (0.914–0.992)	0.020
Gensini score	0.01	0.01	3.4	1.015 (0.999–1.030)	0.064
Constant	–3.9	2.5	2.5	0.021	0.113
R <sup>2</sup> Nagelkerke, Cox & Snell			0.422/0.309		
<b>Coronary artery disease</b>					
CRP [mg/dL]	1.3	0.5	6.5	3.677 (1.351–10.012)	0.011
QRS duration [ms]	0.07	0.03	8.8	1.077 (1.025–1.131)	0.003
LVEF [%]	–0.1	0.02	8.5	0.937 (0.897–0.979)	0.004
Constant	–4.6	2.7	2.8	0.011	0.094
R <sup>2</sup> Nagelkerke, Cox & Snell			0.449/0.333		
<b>Normal coronary arteries</b>					
CRP (mg/dl)	1.1	0.7	2.2	2.983 (0.702–12.7)	0.139
QRS duration [ms]	0.003	0.05	0.002	1.003 (0.903–1.114)	0.962
LVEF [%]	0.01	0.06	0.01	1.006 (0.890–1.136)	0.925
Constant	–2.481	6.5	0.2	0.084	0.701
R <sup>2</sup> Nagelkerke, Cox & Snell			0.162/0.107		

OR — odds ratio; CI — confidence interval; CRP — C-reactive protein; LVEF — left ventricular ejection fraction;  $\beta$  — beta coefficient; SE — standard error; \*Logistic regression analysis with Backward LR method was used for multivariate analysis of independent variables including age, uric acid, creatinine, C-reactive protein and presence of coronary artery disease, which were significantly different in univariate analysis. After exclusion of irrelevant variables from the model, logistic regression analysis with the enter method was performed with the remaining significant variables, and the obtained results are presented

supported this reverse relation between fQRS and LV systolic functions. Additionally, chronic ischaemia can cause myocardial patchy fibrosis without prior myocardial infarction [24]. Similarly, in our study, coronary atherosclerotic burden and extent of CAD were related to fQRS.

In a prior study by MacAlpin [25], the existence of fQRS even in the absence of determinable myocardial fibrosis was shown. They speculated that this could be due to a depolarisation abnormality or low-grade fibrosis undeterminable by the used technique or a normal variant. But they did not search for possible determinants of this abnormality. Therefore, we tested the hypothesis that fQRS may represent the altered ventricular depolarisation which can be derived from different mechanisms, not only fibrosis. Therefore, we think that there may be a causative association of fQRS with inflammation except for LV systolic dysfunction in patients with stable CAD or normal coronary arteries. We found that fQRS was independently related to systemic inflammation and prolonged QRS time, independently of ischaemia and LV dysfunction in our study. An interesting finding was that fQRS existed even in patients with normal coronary arteries and was especially related to increased CRP and prolonged QRS time.

In a prior study, CRP has been shown to be able to directly induce cardiac fibrosis and inflammation by cardiac fibro-

blasts and also promote angiotensinogen (AT) II-mediated cardiac remodelling *in vivo* and *in vitro* by up-regulating the AT1 receptor and by enhanced activation of the transforming growth factor beta (TGF- $\beta$ )/Smad and nuclear factor kappa B (NF- $\kappa$ B) signalling pathways [26]. Similarly, tumour necrosis factor-alpha (TNF- $\alpha$ ), interleukin-1 beta (IL-1 $\beta$ ), and tumour necrosis factor-like weak inducer of apoptosis (TWEAK) could play roles in inducing myocardial fibrosis by the NF- $\kappa$ B pathway [27–29]. Systemic inflammation has been shown to play a significant role in cardiac arrhythmias and conduction disturbances [30, 31]. The possible reason for cardiac arrhythmias and conduction disturbances seems to be related to myocardial inflammation, focal fibrosis and ischaemia within the conduction system [31]. In a recent study, Kadi et al. [32] showed that fQRS is increased even in patients with rheumatoid arthritis without cardiovascular disease. This suggests that inflammatory processes may play a pivotal role in producing the fragmentations on ECG.

#### Limitations of the study

In our study, we found a relation between CRP and fQRS independent of other study parameters; but increased CRP may only be a ‘bystander’, in other words be the result of undetermined inducers which may induce both production

of fQRS and CRP. The possible dose-response relation between CRP and the development of fQRS may be evaluated in such a study in which dynamic changes of fQRS with different CRP levels are shown.

Prolonged QRS time was related to fQRS even in relatively normal range of QRS (< 120 ms). This relation may have two possible explanations. Either fragmentation on QRS complex is induced by prolongation in QRS time, or fragmentation on QRS causes an increase in the duration of QRS complex. But, by our study design, we can only speculate which one is the cause, with the other one being the result of or response to fragmentation. This interaction needs to be investigated to clarify the cause-result relationship in an electrophysiology-based study.

### CONCLUSIONS

In our study, we found that fQRS was related to increased CRP. Additionally, QRS time, the extent of CAD, and LV systolic dysfunction, were also independent predictors for fQRS. Fragmented QRS complexes, which may come about as a result of inflammation at cellular level, can represent an increased cardiac risk in patients with stable CAD. Fragmented QRS is a simple, cheap and non-invasive modality that could be a valuable tool for predicting cardiac status and prognosis.

In addition, fragmentations on ECG may be useful for identifying patients who should be investigated and treated for their increased inflammatory status and possible chronic infections.

**Conflict of interest:** none declared

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# Niezależny związek między ogólnoustrojowym stanem zapalnym a fragmentacją zespołów QRS u chorych ze stabilną dławicą piersiową

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## Streszczenie

**Wstęp:** Fragmentacja zespołów QRS (fQRS) jest często obserwowana w rutynowym badaniu EKG, w którym stwierdza się wąskie lub szerokie zespoły QRS. Definiuje się ją jako różnego typu RSR' ( $\geq 1$  R' lub zawężone załamki S lub R) w dwóch sąsiadujących ze sobą odprowadzeniach odpowiadających obszarowi unaczynienia lewej tętnicy wieńcowej. We wcześniejszych badaniach wykazano, że fQRS wiąże się ze zwiększoną chorobowością i śmiertelnością oraz częstszym występowaniem nagłych zgonów sercowych i zdarzeń sercowo-naczyniowych. Wykazano istnienie związku przyczynowego między fQRS a włóknieniem miokardium, jednak nie zbadano, czy istnieją różne mechanizmy prowadzące do rozwoju fQRS.

**Cel:** Celem niniejszego badania była ocena zależności między systemowym zapaleniem a obecnością fQRS u chorych ze stabilną dławicą piersiową.

**Metody:** Do badania włączono kolejnych 353 pacjentów, u których w okresie od kwietnia do grudnia 2010 r. wykonano koronarografię w ośrodku autorów w związku z podejrzeniem choroby wieńcowej (CAD). U wszystkich chorych stwierdzono dławicę piersiową lub objawy dławicowe z dodatnim wynikiem próby wysiłkowej lub badania perfuzji miokardium. Pacjenci, którzy niedawno przebyli ostry zespół wieńcowy z lub bez uniesienia odcinka ST, chorzy z istotną organiczną wadą zastawkową, osoby, u których w badaniu EKG załamek QRS  $\geq 120$  ms, a także chorzy stosujący stałą stymulację serca zostali wykluczeni z badania.

**Wyniki:** Pacjenci z fQRS byli starsi ( $p = 0,01$ ), mieli wyższe stężenie białka C-reaktywnego (CRP) ( $p < 0,001$ ), przedłużony czas trwania QRS ( $p < 0,001$ ) i bardziej zaawansowaną CAD ( $p < 0,001$ ) niż osoby, u których nie stwierdzono cech fQRS. Wieloczynnikowa analiza regresji logistycznej wykazała istnienie: dodatniej korelacji między fQRS a zwiększonym stężeniem CRP (OR 3,8; 95% CI 1,573–9,278;  $p = 0,003$ ), czasem trwania QRS (OR 1,1; 95% CI 1,008–1,101;  $p = 0,019$ ) i ujemnej korelacji z frakcją wyrzutową lewej komory (OR 1,0; 95% CI 0,914–0,992;  $p = 0,020$ ).

**Wnioski:** W niniejszym badaniu wykazano, że fQRS było niezależnie związane z podwyższonym stężeniem CRP, czasem trwania QRS i dysfunkcją skurczową lewej komory. Fragmentacja QRS, która może być następstwem procesu zapalenia na poziomie komórkowym, powoduje poprzez różne mechanizmy zwiększenie ryzyka sercowo-naczyniowego u pacjentów ze stabilną CAD. Ponadto cechy fragmentacji w EKG mogą być przydatne w identyfikowaniu pacjentów, których należy przebadać i leczyć pod kątem nasilonego stanu zapalnego i możliwych przewlekłych infekcji.

**Słowa kluczowe:** fragmentacja QRS, fQRS, choroba wieńcowa, ryzyko sercowo-naczyniowe, zapalenie, dysfunkcja lewej komory, miażdżyca naczyń wieńcowych

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